Effects of irrigation with treated wastewater on Some Chemical Soil Properties in Parkandabad[1]

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Abstract

The use of treated wastewater, as a marginal quality water, in agriculture is a justified practice, yet care should be taken to minimize adverse environmental impacts and to prevent soil deterioration. The objective of this research was to investigate the long-term effects of irrigation with treated wastewater on some chemical soil properties. The investigation was carried out by comparison of soil properties in two different fields; one irrigated with the effluent from Parkandabad Wastewater Treatment Plant over a period of six years and the other one irrigated with water over the same period of time. Soil samples were taken from different depths of 0-25, 25-50, 50-100, 100-150 and 150-200 cm in both fields, and analyzed for various chemical properties. The results indicated that Chlorine was increased significantly, in all depths, in the soil irrigated with the treated wastewater. The use of treated wastewater increased exchangeable Potassium, Magnesium and Phosphorous significantly in the top soil layer (0-25), while the increase in Calcium was occurred up to depth of 50 cm. Irrigation with the treated wastewater increased soil Sodium content in all depths except for the depth of 100-150 cm. Irrigation with the treated wastewater did not affect the soil Nitrogen content significantly.

Key words: Irrigation, Wastewater, Chemical soil properties, Mashhad

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1. Intrudution

Wastewater as a source full of water and fertilizing elements required for the plants has been used for irrigating and growing agricultural produce at many places of the world since ancient times [5,6,8]. Using waste water and treated waste water obtained from the treatment plants in farmlands is not recommended due to the complexity they have in acquiring process as well as the health (hygienic) and ecological problems without any planning and designing and it can bring about various undesirable effects on ecology [1, 4].

Today, doing local research on using all kinds of unconventional (including wastewater) in irrigating the farmlands and studying the effects of which from different aspects have been of great importance. Due to the variety of climate, cultivars and various flora, the social –cultural conditions, the quality of soil and the characteristics of wastewater in different regions relying on applying the provided instructions in other regions has been a great mistake in long term and subsequently, will bring up irreparable damages to the soil and water supply [1].

Mashhad as one of the largest cities in Iran has a considerable house treated wastewater, which if not used, it must be disposed. If the treatment plants are developed, in 2016 annually about 450 million cubic meters of house treated wastewater will be produced in Mashhad.

In line with the increase in local research, the present study in the field of applying treated waste water of one of the treatment plants of Mashhad (Parkandabad Treatment Plant) in the agriculture. With respect to the fact that treated waste water of this treatment plant has been used as the irrigation water in the fields of the region for several years, the present study deals with the effect of irrigation with treated waste water from this treatment plant on some of the chemical properties of the irrigation water .

2. Materials and Methods

Considering the goal of this project which is to study the long-term effects due to irrigation with Parkanabad treated wastewater on the chemical properties of the soil, and regarding the data gathered from the fields of the region, two pieces of farmland close to each other have been selected which have both had nearly the same kind of crop and cultivated area during the last few years, the texture of the soil of both fields have been assessed, after performing experiments, silty-clay-loam. The former was irrigated with treated waste water for six years and the latter was irrigated with the well water.

After the selection of the above mentioned pieces of land, the excavation locations on the selected pieces of land was determined so that it covers all the various parts of the land, for this purpose the excavation locations were specified systematically with the selective starting point and with the equal intervals in an S shape path in each of the pieces of land. In the locations specified for excavation, wells with the depth of two meters were dug. Each well was divided into 0-25, 25-50, 50-100, 11-150, 150-200 centimeter spans and each span was sampled from the soil around the well-wall with the approximate weight of 3 to five kilograms.

In order to study the chemical properties of the soil samples, a few parameters with the standard application methods for laboratory were specified. Which the parameters measured include sodium, calcium, magnesium solution, exchangeable potassium, soluble chlorine, nitrogen (azotes) and absorbable phosphorous.

3. Experimental results

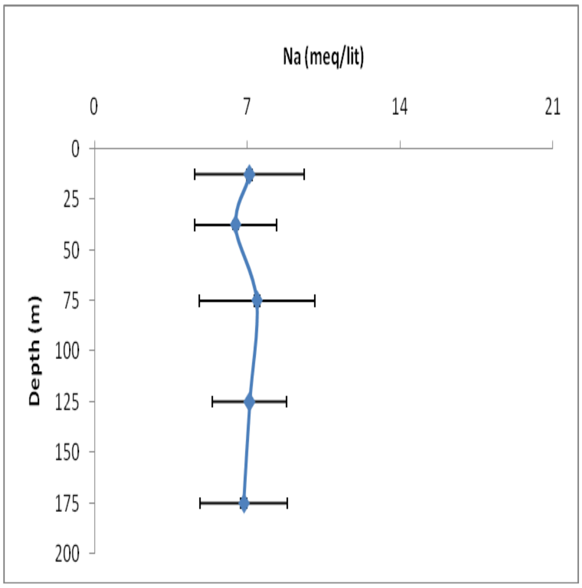
In order for studying the effects of irrigation with treated water on the properties of soil, one should compare the properties of the water used, because the difference in the characteristics of two types of soil is resulting from the difference of the properties of the water used. In the table (1) the parameters applied in this study for both the irrigation water has been presented.

Table1. Comparison of some of the parameters of well water and treated waste water

treated waste water	well water	Unit	Parameter
7.6	7.5	—	pH
1030	471	mg/kg	TDS
1.649	0.491	ds/m	EC
272	—	mg/lit	BOD
60.6		mg/lit	TSS
81.2	1.8	mg/lit	PO_4-P
132	2.5	mg/lit	NO_3-N
0.5	0.45	mg/lit	NH_3-N
0	0	meq/lit	CO_3^-
9.6	3.8	meq/lit	HCO_3^-
5.1	2.4	meq/lit	Cl^-
3	2.3	meq/lit	SO_4^-
2.8	2.6	meq/lit	Ca^{++}
2.3	0.8	meq/lit	Mg^{++}
11.9	4.9	meq/lit	Na^+
0.21	0	meq/lit	K^+
8.8	3.8	—	SAR

** The amount of parameters of the treated waste water has been for monthly average during 3 years of measurement (1999-2002).*

As you can see in the table (2) and figure (1), the sodium concentration in the solutions of the soil irrigated with treated waste water is more than the concentration of the soil irrigated with the well-water. This difference is due to the fact that the average concentration of the sodium in treated waste water is more than the well-water . The aggregation of sodium is also in the superficial water more than the underlying layers. Generally, the pattern of spreading of the soluble sodium over the superficial layers of soil (0-30 cm) is similar to the distribution of the salts. Since the major sodium of the superficial soil is solution [2,4].



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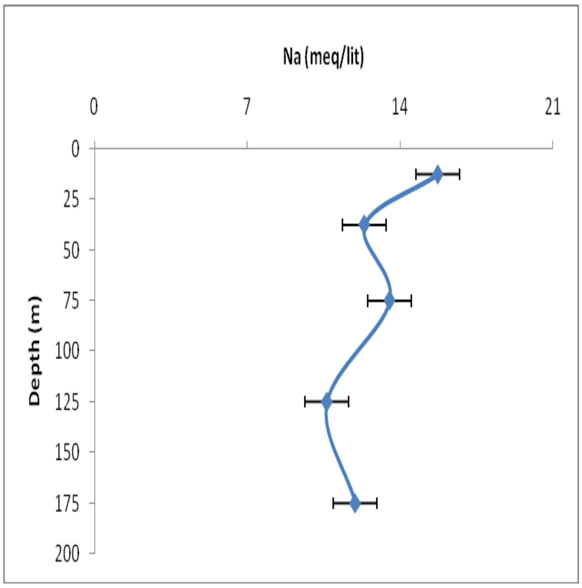

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Figure 1. Indicates the changes in Na of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

Table (2) indicates a significant difference resulting from the mean test in the depths of 25-0 and 50-25 for the soluble calcium content in the soil. Fig (2) Also indicates that in the depth of 25-0 cm .There is more increase in relation to the depth of 50-25 cm. The comparison between the concentration of the calcium present in the well water and the treated waste water does not show much difference (table 1). Although the concentration of this element in the treated waste-water has been proved to be more. On the other hand, the sodium present in the treated waste water is more than the content in the well-water. Sodium can substitute calcium and magnesium in the soil particles and release them and subsequently increase their content in the solution of the soil.

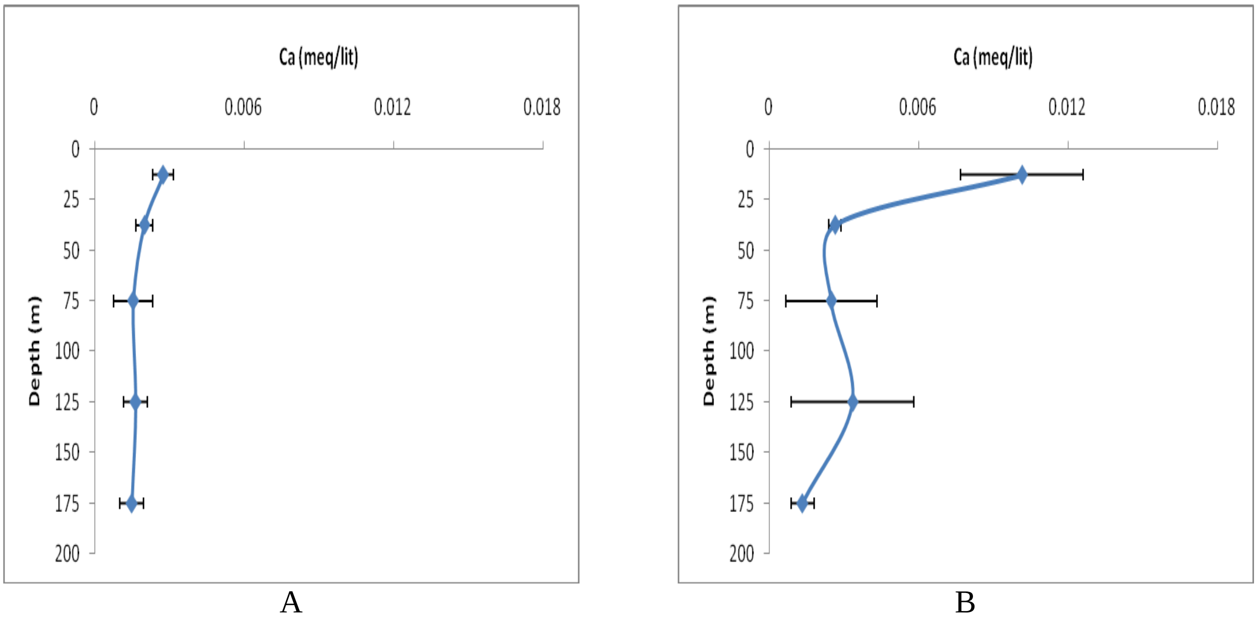


Figure 2. Indicates the changes in Ca of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

Table (2) and fig.(3) indicate that the procedures of the change in the concentration of the soluble magnesium in different layers of soil studied is similar to this procedure in the calcium content, with the difference that irrigation with the treated wastewater up to the depth of 25 cm. Resulting in significant increase of the concentration of this element in the soil. Due to the fact that part of the minerals present in the soil are reduced, and also because of the presence of the considerable amount of organic substances, irrigation with the treated wastewater can change the physical as well as chemical properties of the soil. These compounds and materials after entering the soil and oxidation can reduce the concentration of ions H+ and Ph of the soil. This reduction would increase the solvency of the Calcium Carbonates and Magnesium and consequently increases the calcium and magnesium content of the soil [3].

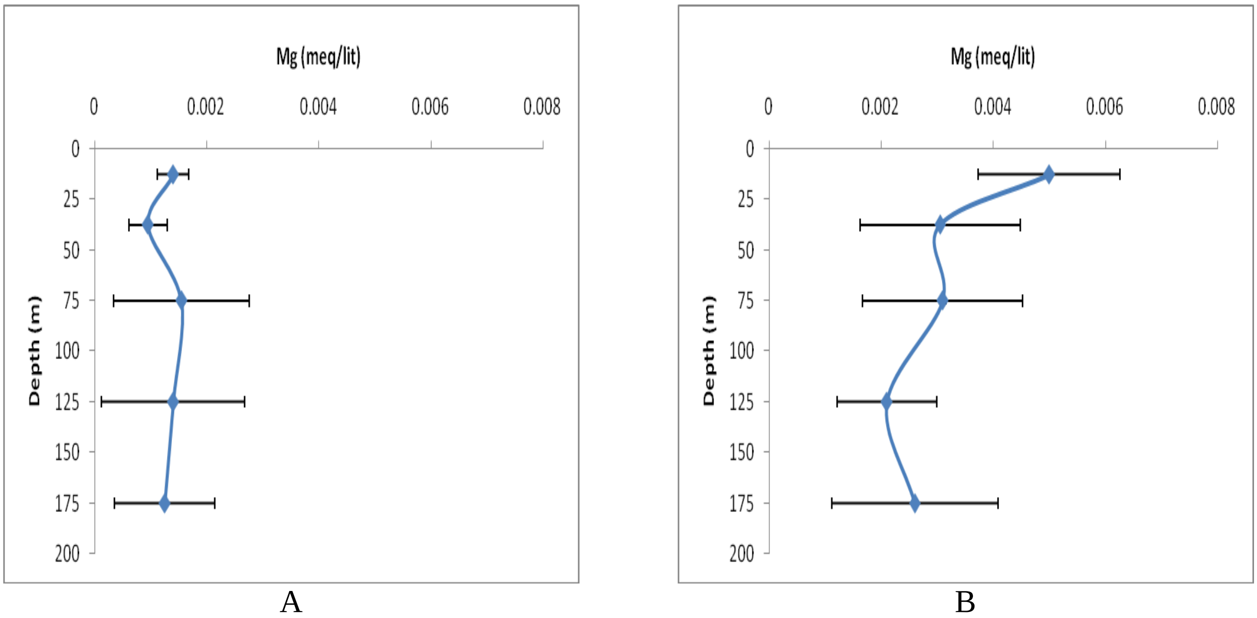
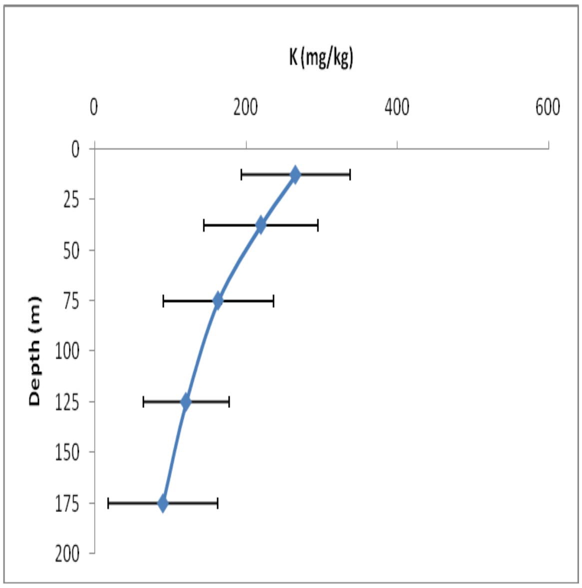


Figure 3. Indicates the changes in Mg of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

Fig (4) shows the increase of the exchangeable potassium content due to the effects of the irrigation with the treated waste-water and the irrigation water at different depths of the soil studied. As the mean test show (table 2), increase of the exchangeable potassium affected by the irrigation with the treated wastewater is only significant at the surface layer of the soil and the difference among the averages of the concentration is not remarkable at all. Since potassium has a high ionizing potential can simply move together with the anions soluble in the soil, but in the clay their potentiality for movement is low [4]. The salts of potassium as well as other salts due to the vaporization of water are aggregated on the surface of the soil.



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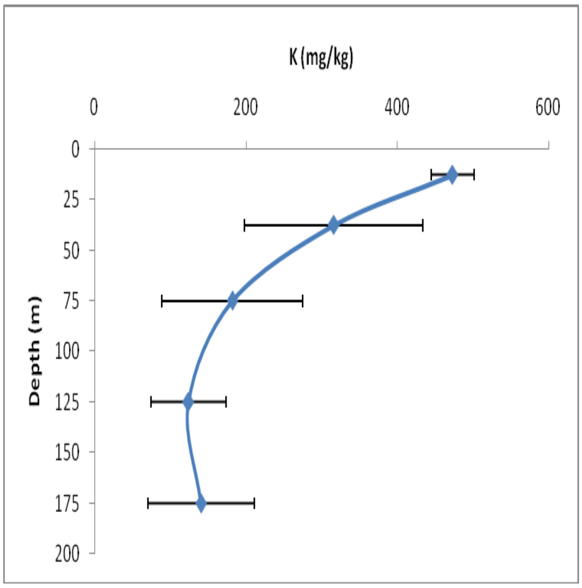
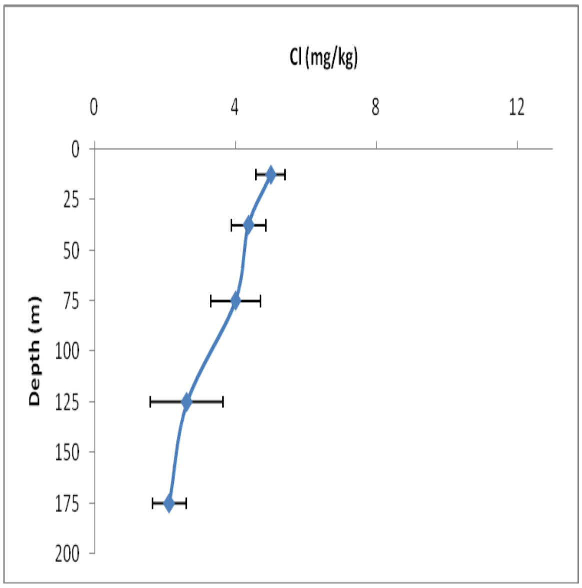


B

Figure 4. Indicates the changes in K of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

The concentration of chlorine in various depths of soil on the field irrigated with treated waste-water is more than the concentration in the similar depths and it suggests that it has been irrigated with well-water .Studying the results of the mean test (table 6) also suggests that the difference in the aggregation of the concentration at all the depths in these two soil have been significant. On the other hand, although the chlorine content in relation to the depth in each soil has had a reducing procedure, but the difference in the concentration of various depths has not been significant and this shows that this element has uniformly been distributed and facilitates the transfer of chlorine in the depth of the soil and underground waters.



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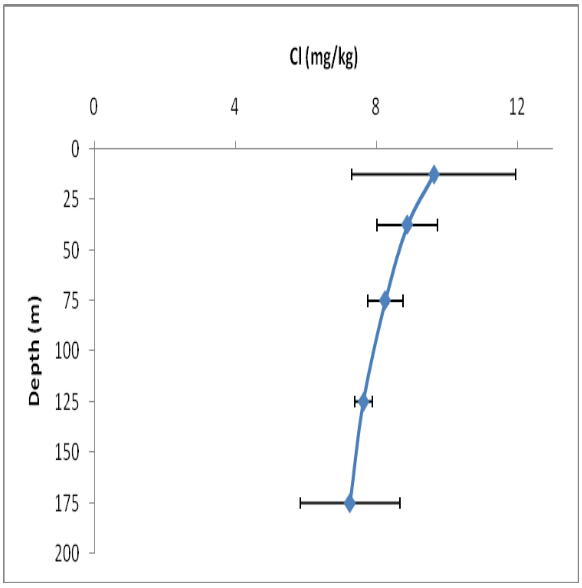

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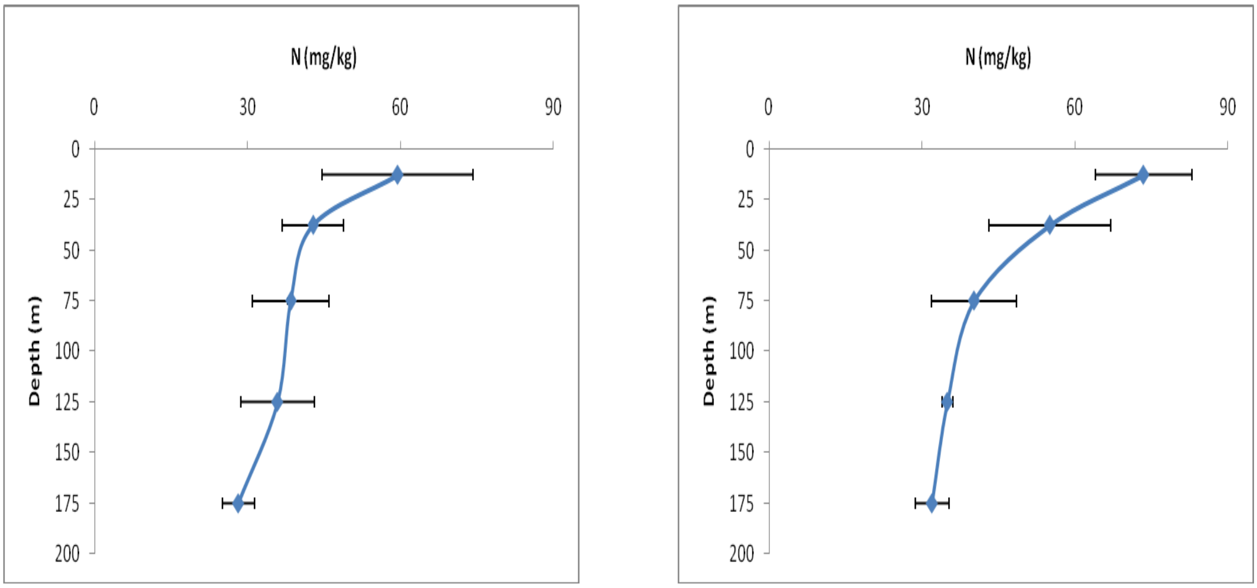
Figure 5. Indicates the changes in Cl of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

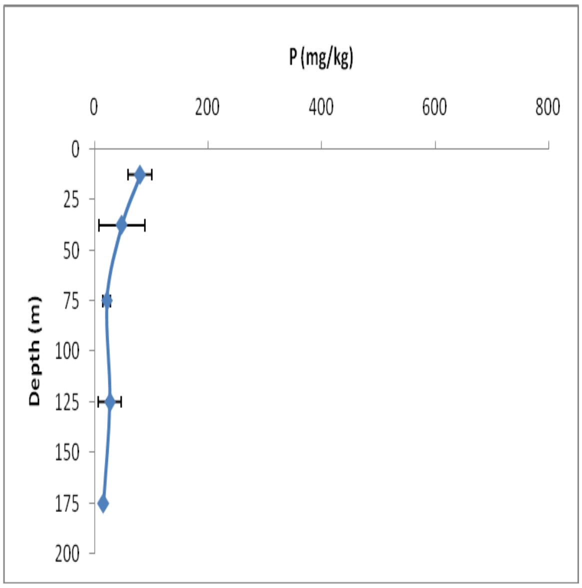
In this study, the results of the measurements of nitrogen is due to its increase in the soil irrigated with treated waste-water, but the results of the statistical mean test (fig 6 & table 2) demonstrates that between the average of the total nitrogen in various depths of this soil and the soil irrigated with well-water, there is no significant difference. With regard to the average nitrogen present in the treated waste-water (table 1) it was expected that nitrogen concentration in the soil irrigated with treated waste-water has had a remarkable increase in comparison with its content in the soil irrigated with well water but factors such as water wash of the Nitrite nitrogen, plant application and nitrification- de-nitrification of nitrogen, animal and chemical fertilizers in the field irrigated with well-water can be of the reasons why there is no significant difference among the nitrogen content of these soils [7].



A B

Figure 6. Indicates the changes in N of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

As it can be seen from the comparison made between the averages, irrigation with treated waste water increases the absorbable phosphorus of the surface soil remarkably (50-0cm). But the effect of the lower depths on the increase of the absorbable phosphorus in comparison with well-water was not significant (fig. 7 & table 2). The aggregation of phosphorus in the top soil layer is due to low potential of phosphorus for moving in the soil. The phosphorus has a little potential for movement and absorption by the soil particles and that is why their utmost aggregation can be seen on the top soil layer. That is why the danger for contamination of the underground water is very low but if the particles are washed and transferred to the surface waters the danger of utrification will exist.



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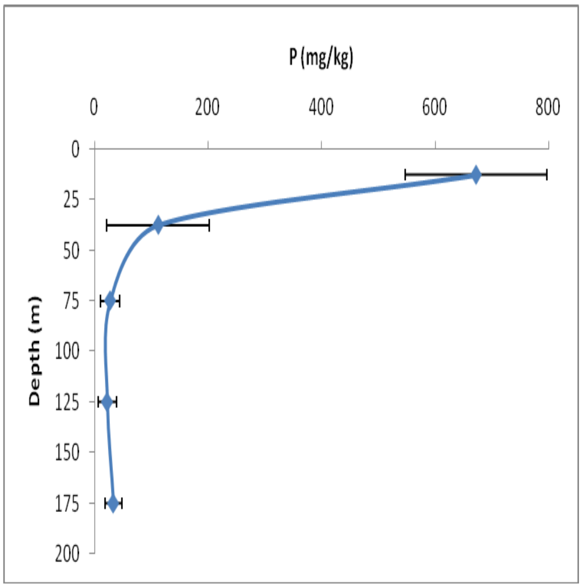

B

Figure 7. Indicates the changes in P of the soil in relation to the depth:
"A" field irrigated with well water, "B" filed irrigated with treated waste water.

Table 2. The average of parameters in different depths of the soil and the results of the data mean tests

land irrigated with treated wastewater					land irrigated with well water					
Sampling depths (cm)					Sampling depths (cm)					parameter
100-200	**100-150**	**50-100**	**25-50**	**0-25**	**100-200**	**100-150**	**50-100**	**25-50**	**0-25**	
11.95	10.7	13.5	12.4	15.7	6.8	7.1	7.45	6.5	7.1	**Na** (meq/lit)
0.0014	0.0034	0.003	0.003	0.001	0.0015	0.0017	0.002	0.002	0.0028	**Ca** (meq/lit)
0.004	0.0021	0.002	0.002	0.005	0.0015	0.0014	0.0016	0.0009	0.0014	**Mg** (meq/lit)
140.8	124.1	182	316.1	472.2	90.5	121	163.7	220.1	265.8	**K** (meq/lit)
7.2	7.6	8.25	8.9	9.6	2.1	2.6	4	4.4	5	**Cl** (meq/lit)
31.6	35	40.2	55.1	73.5	28.2	35.8	38.5	42.8	59.5	**N** (mg/lit)
33	22.6	27.5	112	671.8	15.4	26.8	21.7	48.3	80.4	**P** (mg/lit)

NonsSignificant S: ☐ *Significant:* ■

4. Conclusion

As it was already mentioned, the present research has been done in order to study the effects of the treated waste water on the chemical properties of the soil while irrigating the agricultural crops. we come to this conclusion that irrigation by the treated waste water of Parkand Abad Treatment Plant over a period of six years will increase Chlorine at all the depths of the soil, magnesium, potassium and phosphorus on the top soil layer and sodium and calcium at some of the depths significantly, also irrigation with the treated waste water has no significant effect on the total Nitrogen of the soil at all the depths.

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